深入浅出Flink(6)

一 、课前准备

掌握上次课内容

二 、课堂主题

掌握Flink window知识

三 、课程目标

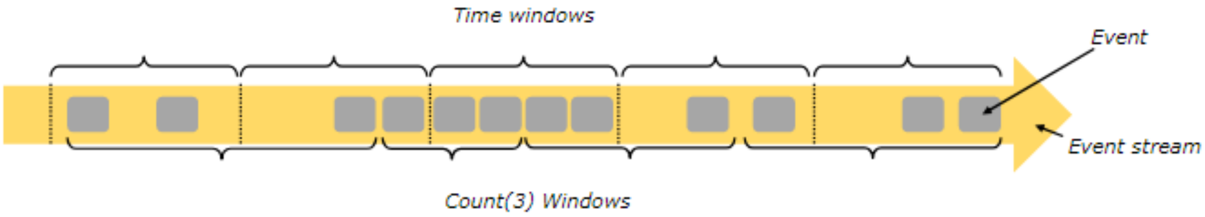
1. 掌握window的类型
2. 了解Window的常用方法

四 、知识要点

4.1 Window概述

聚合事件（比如计数、求和）在流上的工作方式与批处理不同。比如，对流中的所有元素进行计数是不可能的，因为通常流是无限的（无界的）。所以，流上的聚合需要由 window 来划定范围，比如 “计算过去的5分钟” ，或者 “最后100个元素的和” 。window是一种可以把无限数据切割为有限数据块的手段。

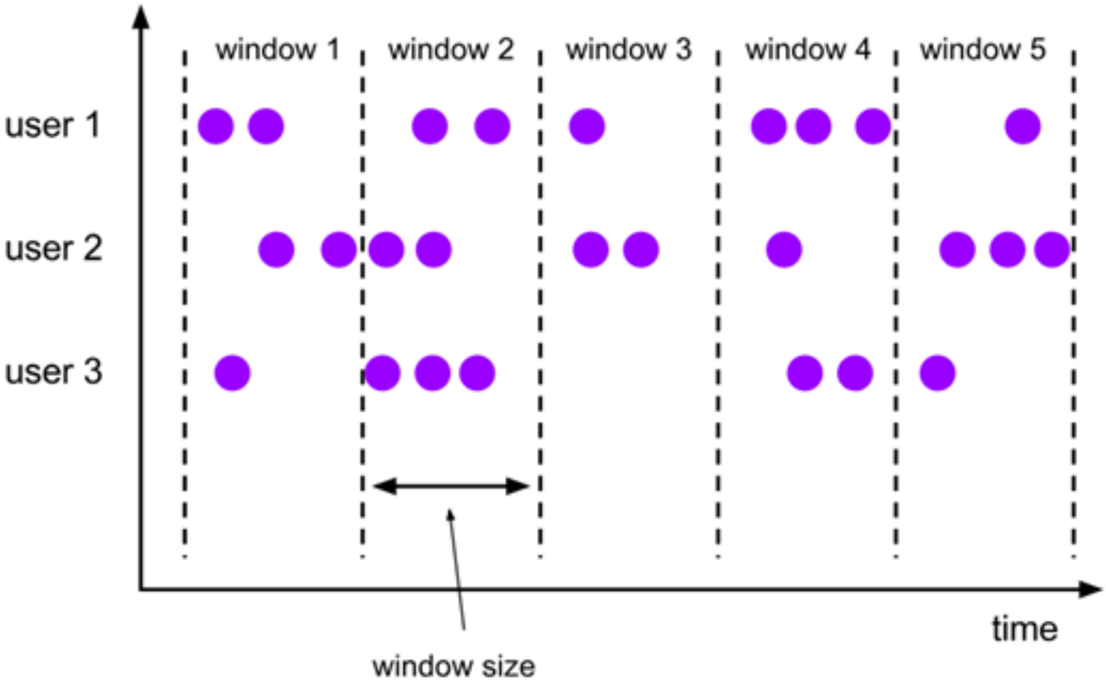
窗口可以是 时间驱动的 【Time Window】 （比如：每30秒）或者 数据驱动的【Count Window】 （比如：每100个元素）。



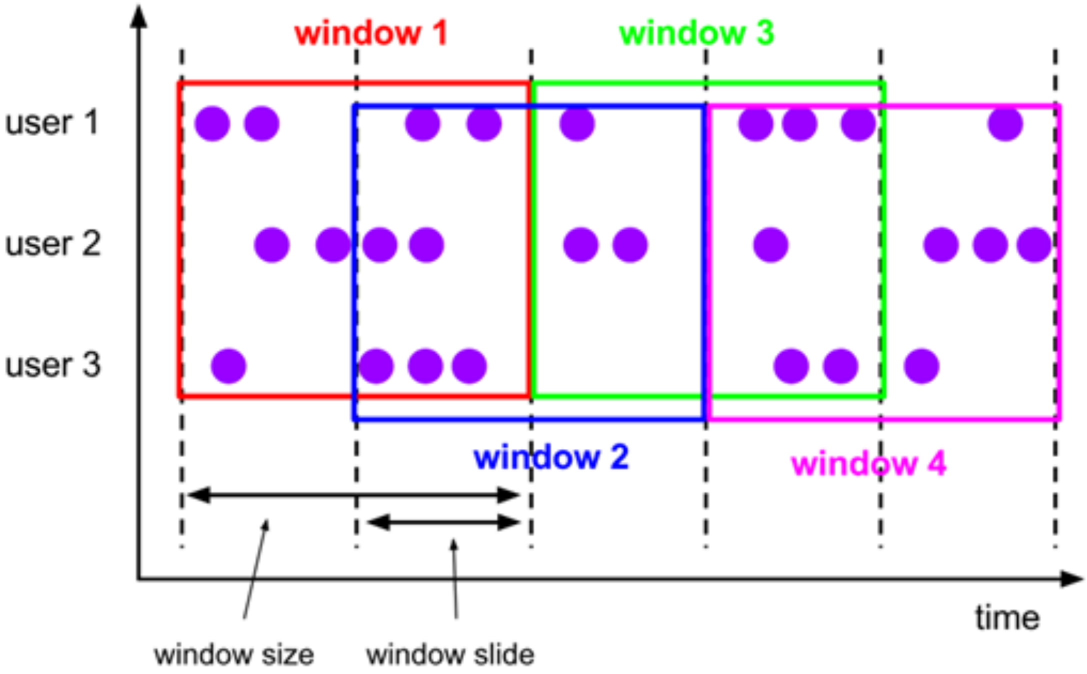
4.2 Window类型

窗口通常被区分为不同的类型: tumbling windows：滚动窗口 【没有重叠】 sliding windows：滑动窗口 【有重叠】 session windows：会话窗口 global windows: 没有窗口

4.2.1 tumblingwindows：滚动窗口【没有重叠】



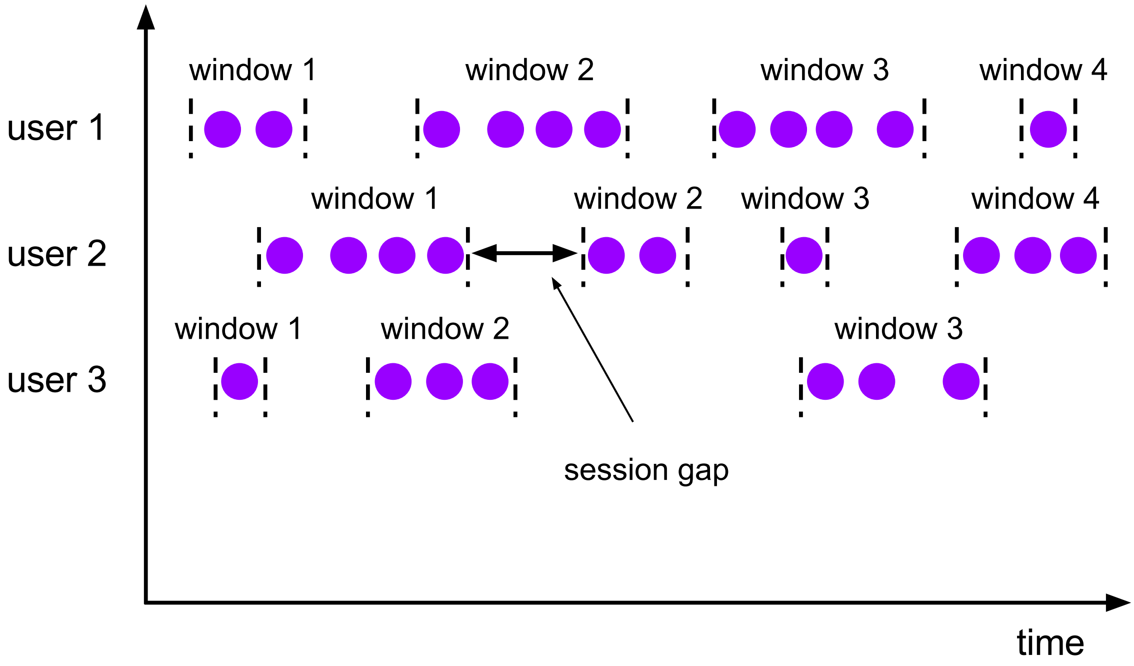
4.2.2 slidingwindows：滑动窗口 【有重叠】



4.2.3 session windows

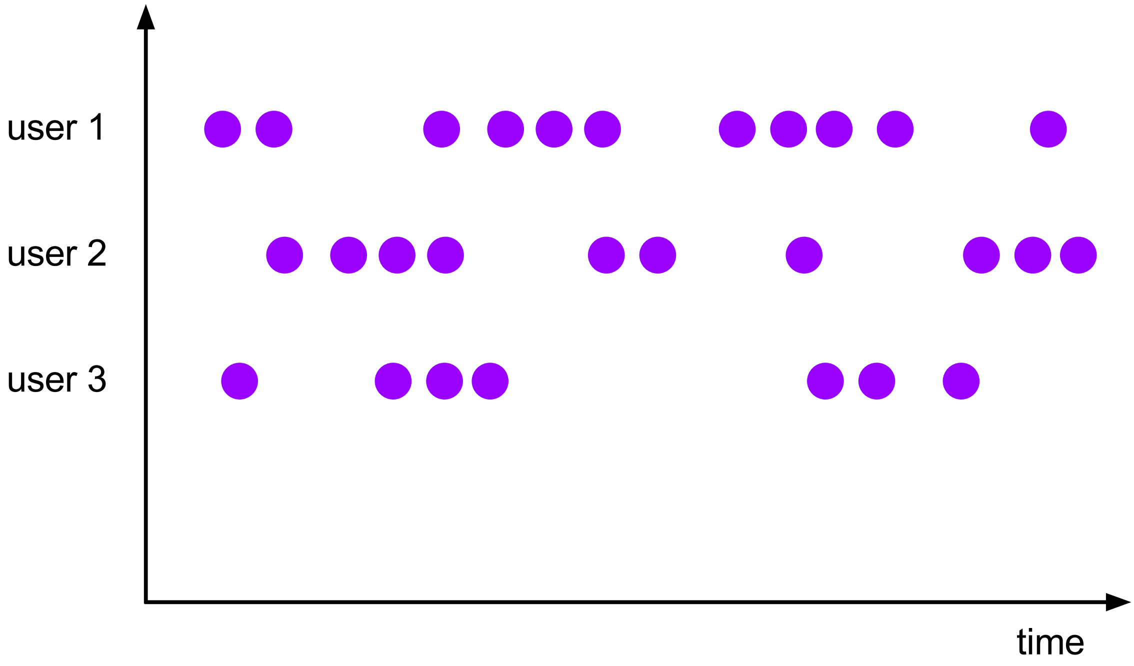
需求：实时计算每个单词出现的次数，如果一个单词过了5秒就没出现过了，那么就输出这个单词。

案例演示：见下方



4.2.4 global windows

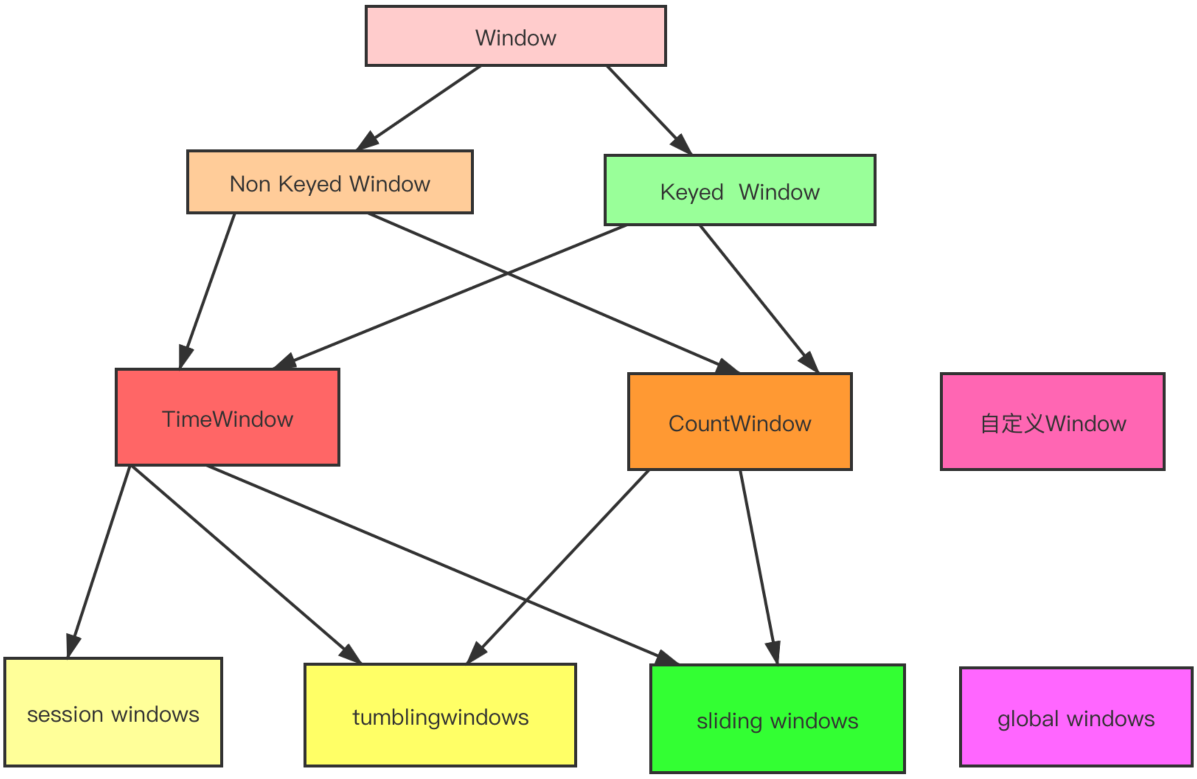
案例见下方



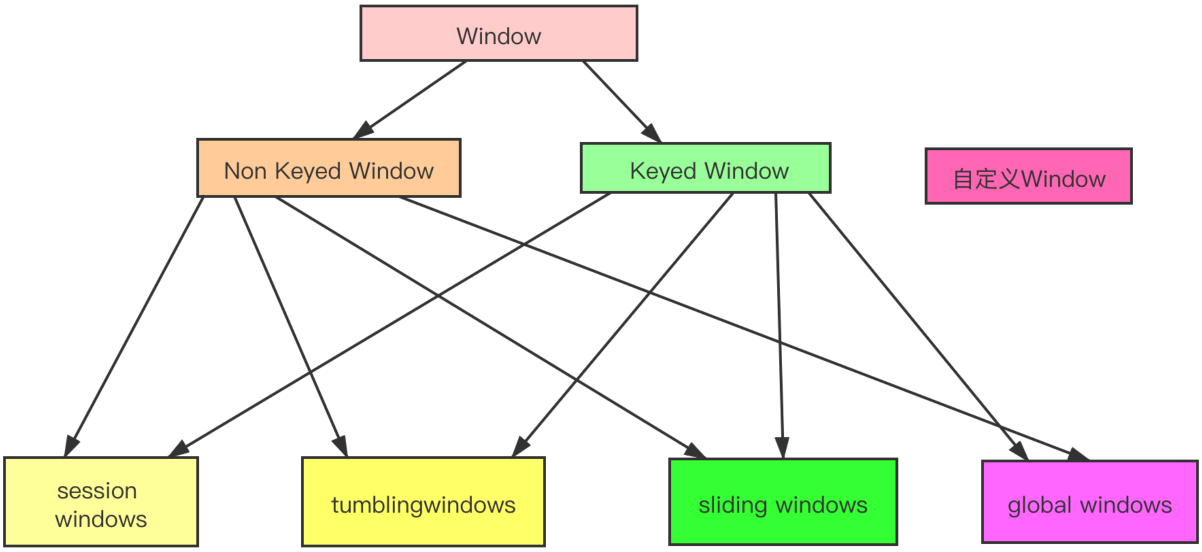
4.2.5 Window类型总结

Keyed Window 和 Non Keyed Window

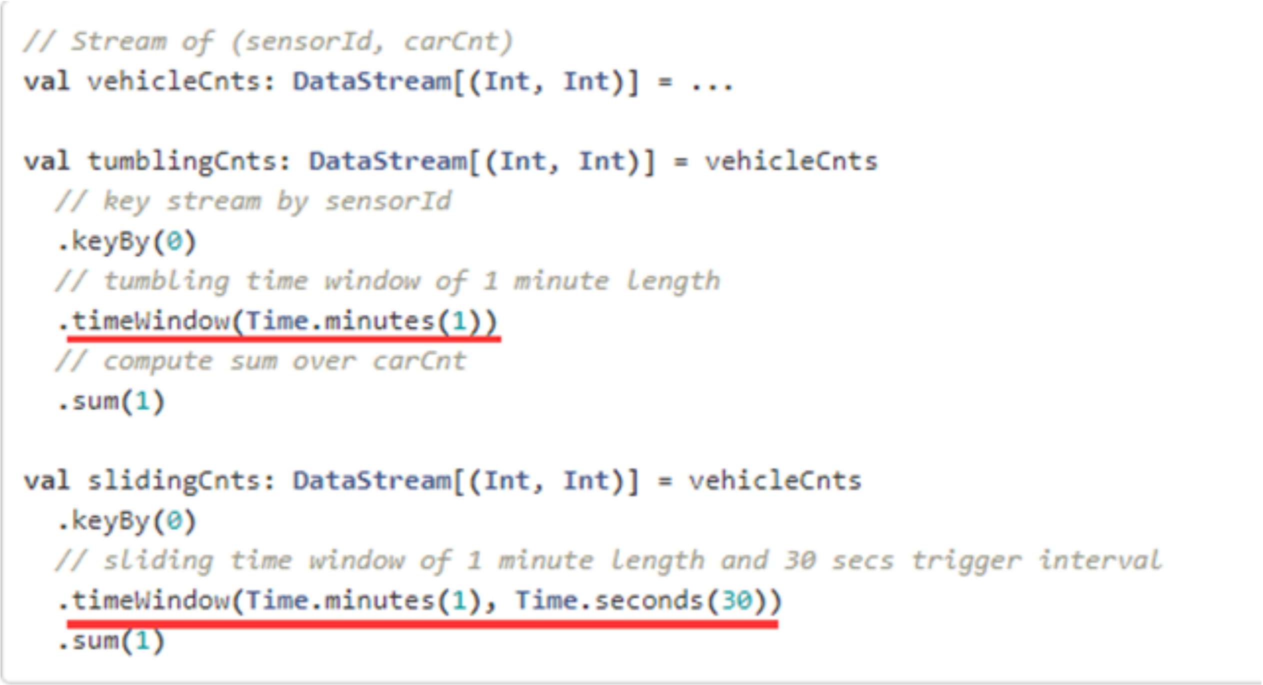
```
/**
 * Non Keyed Window 和 Keyed Window
 */
public class WindowType {
    public static void main(String[] args) throws Exception {
        StreamExecutionEnvironment env = StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream = env.socketTextStream("10.148.15.10", 8888);

        SingleOutputStreamOperator<Tuple2<String, Integer>> stream = dataStream.flatMap(new FlatMapFunction<String, Tuple2<String, Integer>>() {
            @Override
            public void flatMap(String line, Collector<Tuple2<String, Integer>> collector) throws Exception {
                String[] fields = line.split(",");
                for (String word : fields) {
                    collector.collect(Tuple2.of(word, 1));
                }
            }
        });

        //Non keyed Stream
//        AllWindowedStream<Tuple2<String, Integer>, TimeWindow> nonkeyedStream = stream.timeWindowAll(Time.seconds(3));
//        nonkeyedStream.sum(1)
//                .print();

        //Keyed Stream
        stream.keyBy(0)
                .timeWindow(Time.seconds(3))
                .sum(1)
                .print();

        env.execute("word count");


    }
}
```



注意：window 那儿一个是keyed window ,另外一个是nonkeyed window

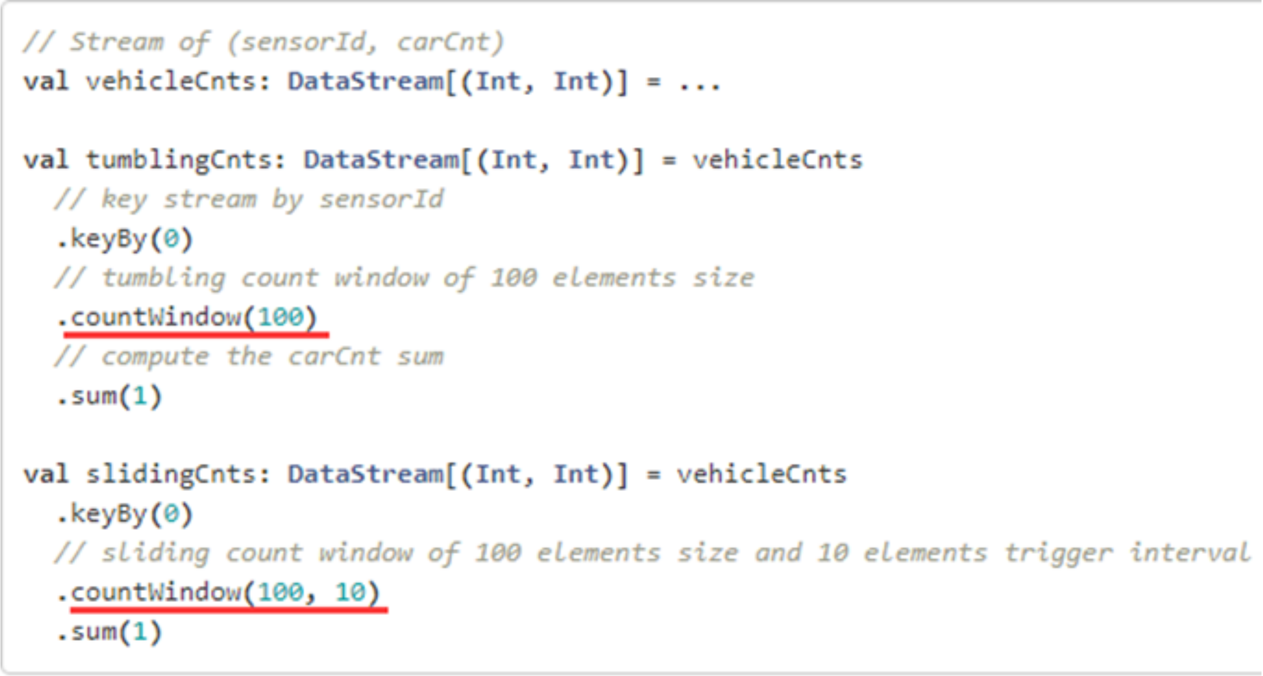


TimeWindow



```
// Stream of (sensorId, carCnt)
val vehicleCnts: DataStream[(Int, Int)] = ...

val tumblingCnts: DataStream[(Int, Int)] = vehicleCnts
  // key stream by sensorId
  .keyBy(0)
  // tumbling time window of 1 minute length
  .timeWindow(Time.minutes(1))
  // compute sum over carCnt
  .sum(1)

val slidingCnts: DataStream[(Int, Int)] = vehicleCnts
  .keyBy(0)
  // sliding time window of 1 minute length and 30 secs trigger interval
  .timeWindow(Time.minutes(1), Time.seconds(30))
  .sum(1)
```

CountWindow



```
// Stream of (sensorId, carCnt)
val vehicleCnts: DataStream[(Int, Int)] = ...

val tumblingCnts: DataStream[(Int, Int)] = vehicleCnts
  // key stream by sensorId
  .keyBy(0)
  // tumbling count window of 100 elements size
  .countWindow(100)
  // compute the carCnt sum
  .sum(1)

val slidingCnts: DataStream[(Int, Int)] = vehicleCnts
  .keyBy(0)
  // sliding count window of 100 elements size and 10 elements trigger interval
  .countWindow(100, 10)
  .sum(1)
```

自定义Window

一般前面两种window就能解决我们所遇到的业务场景了，本人至今还没遇到需要自定义window的场景。

4.3 window操作

Keyed Windows

```
stream
       .keyBy(...)               <-  keyed versus non-keyed windows
       .window(...)              <-  required: "assigner"
      [.trigger(...)]            <-  optional: "trigger" (else default
trigger)
      [.evictor(...)]            <-  optional: "evictor" (else no evictor)
      [.allowedLateness(...)]    <-  optional: "lateness" (else zero)
      [.sideOutputLateData(...)] <-  optional: "output tag" (else no side
output for late data)
       .reduce/aggregate/fold/apply()      <-  required: "function"
      [.getSideOutput(...)]      <-  optional: "output tag"
```

Non-Keyed Windows

```
stream
       .windowAll(...)           <-  required: "assigner"
      [.trigger(...)]            <-  optional: "trigger" (else default
trigger)
      [.evictor(...)]            <-  optional: "evictor" (else no evictor)
      [.allowedLateness(...)]    <-  optional: "lateness" (else zero)
      [.sideOutputLateData(...)] <-  optional: "output tag" (else no side
output for late data)
       .reduce/aggregate/fold/apply()      <-  required: "function"
      [.getSideOutput(...)]      <-  optional: "output tag"
```

4.3.1 window function

Tumbling window和slide window

```
        //1:滚动窗口
        stream.keyBy(0)
               .window(TumblingEventTimeWindows.of(Time.seconds(2)))
                .sum(1)
                .print();
        //2:滑动窗口
        stream.keyBy(0)

.window(SlidingProcessingTimeWindows.of(Time.seconds(6),Time.seconds(4)))
                .sum(1)
                .print();
```

需求

> 实时计算单词出现的次数，但是并不是每次接受到单词以后就输出单词出现的次数，而是当过了5秒以后没收到这个单词，就输出这个单词的次数

解决问题的思路

```
1. 利用state存储key，count和key到达的时间
2. 没接收到一个单词，更新状态中的数据
3. 对于每个key都注册一个定时器，如果过了5秒没接收到这个key到话，那么就触发这个定时器，这个定时器就判断当前的event time是否等于这个key的最后修改时间+5s，如果等于则输出key以及对应的count
```

需求实现

```
/**
 * 5秒没有单词输出，则输出该单词的单词次数
 */
public class KeyedProcessFunctionWordCount {
    public static void main(String[] args) throws Exception {
        // 1. 初始化一个流执行环境
        StreamExecutionEnvironment env =
                StreamExecutionEnvironment.createLocalEnvironmentWithWebUI(new
Configuration());
        // 设置每个 operator 的并行度
        env.setParallelism(1);
        // socket 数据源不是一个可以并行的数据源
        DataStreamSource<String> dataStreamSource =
                env.socketTextStream("localhost", 9999);
        // 3. Data Process
        // non keyed stream
        DataStream<Tuple2<String, Integer>> wordOnes =
                dataStreamSource.flatMap(new WordOneFlatMapFunction());
        // 3.2 按照单词进行分组，聚合计算每个单词出现的次数
        // keyed stream
        KeyedStream<Tuple2<String, Integer>, Tuple> wordGroup = wordOnes
                .keyBy(0);


        wordGroup.process(new CountWithTimeoutFunction()).print();




        // 5. 启动并执行流程序
        env.execute("Streaming WordCount");
    }





    private static class CountWithTimeoutFunction extends
KeyedProcessFunction<
```

```
            Tuple, Tuple2<String, Integer>, Tuple2<String, Integer>> {
        private ValueState<CountWithTimestamp> state;

        @Override
        public void open(Configuration parameters) throws Exception {
            state = getRuntimeContext()
                    .getState(new ValueStateDescriptor<CountWithTimestamp>(
                            "myState", CountWithTimestamp.class));
        }

        /**
         *  处理每一个接收到的单词(元素)
         * @param element   输入元素
         * @param ctx   上下文
         * @param out   用于输出
         * @throws Exception
         */
        @Override
        public void processElement(Tuple2<String, Integer> element, Context
ctx,
                                   Collector<Tuple2<String, Integer>> out)
throws Exception {
            // 拿到当前 key 的对应的状态
            CountWithTimestamp currentState = state.value();
            if (currentState == null) {
                currentState = new CountWithTimestamp();
                currentState.key = element.f0;
            }
            // 更新这个 key 出现的次数
            currentState.count++;

            // 更新这个 key 到达的时间，最后修改这个状态时间为当前的 Processing Time
            currentState.lastModified =
ctx.timerService().currentProcessingTime();

            // 更新状态
            state.update(currentState);

            // 注册一个定时器
            // 注册一个以 Processing Time 为准的定时器
            // 定时器触发的时间是当前 key 的最后修改时间加上 5 秒
            ctx.timerService()
                    .registerProcessingTimeTimer(currentState.lastModified +
5000);
        }

        /**
         *  定时器需要运行的逻辑
         * @param timestamp 定时器触发的时间戳
         * @param ctx   上下文
         * @param out   用于输出
         * @throws Exception
         */
        @Override
        public void onTimer(long timestamp, OnTimerContext ctx,
                            Collector<Tuple2<String, Integer>> out) throws
Exception {
            // 先拿到当前 key 的状态
            CountWithTimestamp curr = state.value();
            // 检查这个 key 是不是 5 秒钟没有接收到数据
            if (timestamp == curr.lastModified + 5000) {
                out.collect(Tuple2.of(curr.key, curr.count));
                state.clear();
            }
        }
    }

    private static class CountWithTimestamp {
        public String key;
        public int count;
        public long lastModified;
    }

    private static class WordOneFlatMapFunction
            implements FlatMapFunction<String, Tuple2<String, Integer>> {

        @Override
        public void flatMap(String line,
                            Collector<Tuple2<String, Integer>> out) throws
Exception {
            String[] words = line.toLowerCase().split(" ");
            for (String word : words) {
                Tuple2<String, Integer> wordOne = new Tuple2<>(word, 1);
                // 将单词计数 1 的二元组输出
                out.collect(wordOne);
            }
        }
    }
}
```

session window

```
/**
 * 5秒过去以后，该单词不出现就打印出来该单词
 */
public class SessionWindowTest {
    public static void main(String[] args) throws  Exception {
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("10.148.15.10", 8888);

        SingleOutputStreamOperator<Tuple2<String, Integer>> stream =
dataStream.flatMap(new FlatMapFunction<String, Tuple2<String, Integer>>() {
            @Override
            public void flatMap(String line, Collector<Tuple2<String,
Integer>> collector) throws Exception {
                String[] fields = line.split(",");
                for (String word : fields) {
                    collector.collect(Tuple2.of(word, 1));
                }
            }
        });

        stream.keyBy(0)
          //3: 会话窗口 5s
                .window(ProcessingTimeSessionWindows.withGap(Time.seconds(5)))
                .sum(1)
                .print();

        env.execute("SessionWindowTest");
    }
}
```

global window

global window + trigger 一起配合才能使用

需求：单词每出现三次统计一次

```
/**
 * 单词每出现三次统计一次
 */
public class GlobalWindowTest {
    public static void main(String[] args) throws Exception {
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("10.148.15.10", 8888);
```

```
        SingleOutputStreamOperator<Tuple2<String, Integer>> stream =
dataStream.flatMap(new FlatMapFunction<String, Tuple2<String, Integer>>() {
            @Override
            public void flatMap(String line, Collector<Tuple2<String,
Integer>> collector) throws Exception {
                String[] fields = line.split(",");
                for (String word : fields) {
                    collector.collect(Tuple2.of(word, 1));
                }
            }
        });

        stream.keyBy(0)
                .window(GlobalWindows.create())
                 //如果不加这个程序是启动不起来的
                .trigger(CountTrigger.of(3))
                .sum(1)
                .print();

        env.execute("SessionWindowTest");
    }
}
```

执行结果：

```
hello,3
hello,6
hello,9
```

总结：效果跟CountWindow(3）很像，但又有点不像，因为如果是CountWindow(3)，单词每次出现的都是3次，不会包含之前的次数，而我们刚刚的这个每次都包含了之前的次数。

4.3.2 Trigger

需求：自定义一个CountWindow

```
/**
 * 使用Trigger 自己实现一个类似CountWindow的效果
 */
public class CountWindowWordCount {
    public static void main(String[] args) throws Exception {
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("10.148.15.10", 8888);
```

```
        SingleOutputStreamOperator<Tuple2<String, Integer>> stream = dataStream.flatMap(new FlatMapFunction<String, Tuple2<String, Integer>>() {
            @Override
            public void flatMap(String line, Collector<Tuple2<String, Integer>> collector) throws Exception {
                String[] fields = line.split(",");
                for (String word : fields) {
                    collector.collect(Tuple2.of(word, 1));
                }
            }
        });

        WindowedStream<Tuple2<String, Integer>, Tuple, GlobalWindow> keyedWindow = stream.keyBy(0)
                .window(GlobalWindows.create())
                .trigger(new MyCountTrigger(3));


            //可以看看里面的源码，跟我们写的很像
//        WindowedStream<Tuple2<String, Integer>, Tuple, GlobalWindow> keyedWindow = stream.keyBy(0)
//                .window(GlobalWindows.create())
//                .trigger(CountTrigger.of(3));


        DataStream<Tuple2<String, Integer>> wordCounts = keyedWindow.sum(1);

        wordCounts.print().setParallelism(1);

        env.execute("Streaming WordCount");
    }



    private static class MyCountTrigger
            extends Trigger<Tuple2<String, Integer>, GlobalWindow> {
        // 表示指定的元素的最大的数量
        private long maxCount;

        // 用于存储每个 key 对应的 count 值
        private ReducingStateDescriptor<Long> stateDescriptor
                = new ReducingStateDescriptor<Long>("count", new ReduceFunction<Long>() {
            @Override
            public Long reduce(Long aLong, Long t1) throws Exception {
                return aLong + t1;
            }
        }, Long.class);
        public MyCountTrigger(long maxCount) {
            this.maxCount = maxCount;
        }

        /**
         *  当一个元素进入到一个 window 中的时候就会调用这个方法
         * @param element   元素
         * @param timestamp 进来的时间
         * @param window    元素所属的窗口
         * @param ctx 上下文
         * @return TriggerResult
         *      1. TriggerResult.CONTINUE ：表示对 window 不做任何处理
         *      2. TriggerResult.FIRE ：表示触发 window 的计算
         *      3. TriggerResult.PURGE ：表示清除 window 中的所有数据
         *      4. TriggerResult.FIRE_AND_PURGE ：表示先触发 window 计算，然后删除
window 中的数据
         * @throws Exception
         */
        @Override
        public TriggerResult onElement(Tuple2<String, Integer> element,
                                       long timestamp,
                                       GlobalWindow window,
                                       TriggerContext ctx) throws Exception {
            // 拿到当前 key 对应的 count 状态值
            ReducingState<Long> count =
ctx.getPartitionedState(stateDescriptor);
            // count 累加 1
            count.add(1L);
            // 如果当前 key 的 count 值等于 maxCount
            if (count.get() == maxCount) {
                count.clear();
                // 触发 window 计算，删除数据
                return TriggerResult.FIRE_AND_PURGE;
            }
            // 否则，对 window 不做任何的处理
            return TriggerResult.CONTINUE;
        }

        @Override
        public TriggerResult onProcessingTime(long time,
                                              GlobalWindow window,
                                              TriggerContext ctx) throws
Exception {
            // 写基于 Processing Time 的定时器任务逻辑
            return TriggerResult.CONTINUE;
        }

        @Override
        public TriggerResult onEventTime(long time,
                                         GlobalWindow window,
                                         TriggerContext ctx) throws Exception
{
            // 写基于 Event Time 的定时器任务逻辑
            return TriggerResult.CONTINUE;
        }

        @Override
        public void clear(GlobalWindow window, TriggerContext ctx) throws
Exception {
            // 清除状态值
            ctx.getPartitionedState(stateDescriptor).clear();
        }
    }

}
```

注：效果跟CountWindow一模一样

4.3.3 Evictor

需求：实现每隔2个单词，计算最近3个单词

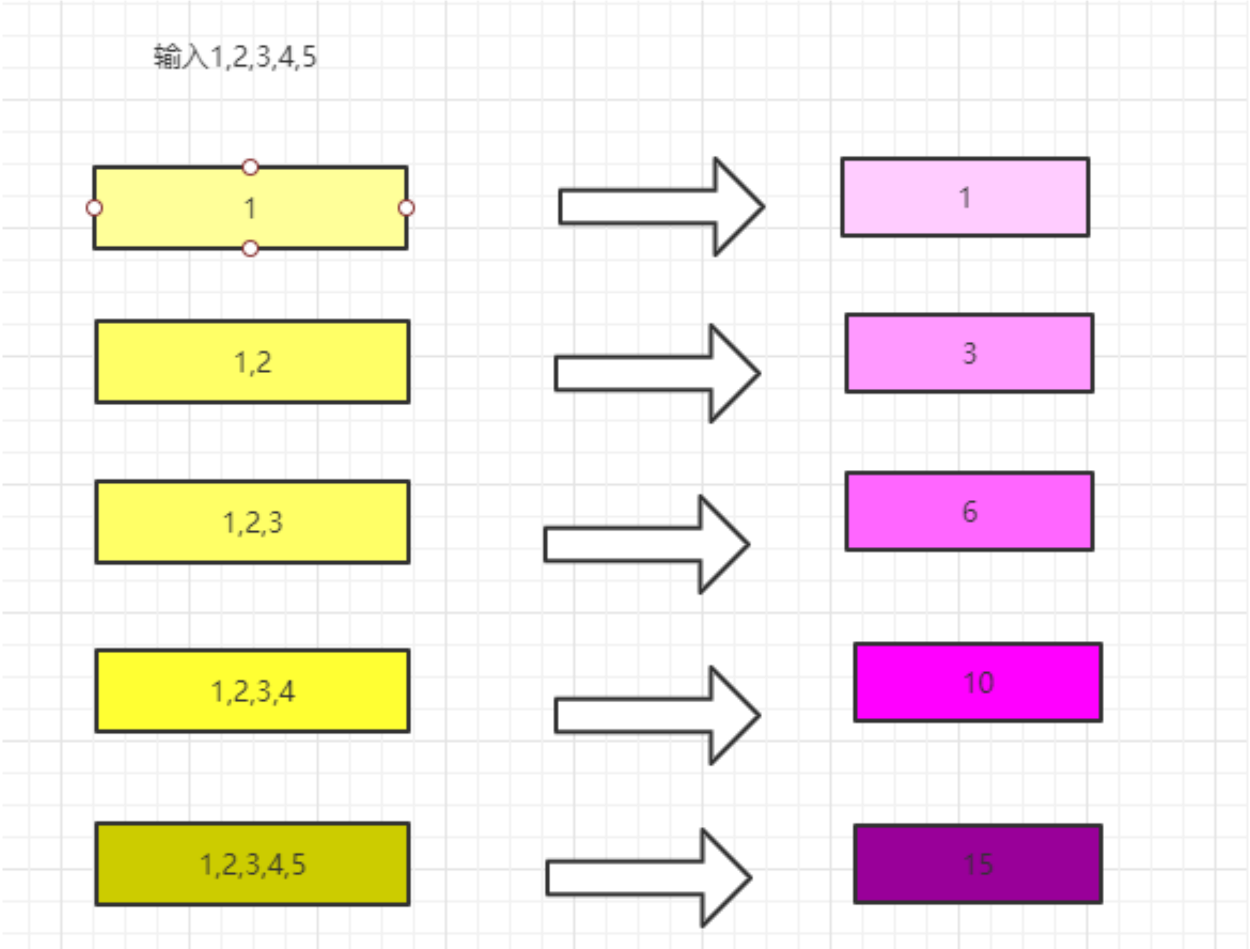
```
/**
 * 使用Evictor 自己实现一个类似CountWindow(3,2)的效果
 * 每隔2个单词计算最近3个单词
 */
public class CountWindowWordCountByEvictor {
    public static void main(String[] args) throws Exception {
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("10.148.15.10", 8888);

        SingleOutputStreamOperator<Tuple2<String, Integer>> stream =
dataStream.flatMap(new FlatMapFunction<String, Tuple2<String, Integer>>() {
            @Override
            public void flatMap(String line, Collector<Tuple2<String,
Integer>> collector) throws Exception {
                String[] fields = line.split(",");
                for (String word : fields) {
                    collector.collect(Tuple2.of(word, 1));
                }
            }
        });

        WindowedStream<Tuple2<String, Integer>, Tuple, GlobalWindow>
keyedWindow = stream.keyBy(0)
                .window(GlobalWindows.create())
                .trigger(new MyCountTrigger(2))
                .evictor(new MyCountEvictor(3));



        DataStream<Tuple2<String, Integer>> wordCounts = keyedWindow.sum(1);

        wordCounts.print().setParallelism(1);

        env.execute("Streaming WordCount");
    }



    private static class MyCountTrigger
            extends Trigger<Tuple2<String, Integer>, GlobalWindow> {
        // 表示指定的元素的最大的数量
        private long maxCount;

        // 用于存储每个 key 对应的 count 值
        private ReducingStateDescriptor<Long> stateDescriptor
                = new ReducingStateDescriptor<Long>("count", new
ReduceFunction<Long>() {
            @Override
            public Long reduce(Long aLong, Long t1) throws Exception {
                return aLong + t1;
            }
        }, Long.class);

        public MyCountTrigger(long maxCount) {
            this.maxCount = maxCount;
        }

        /**
         *  当一个元素进入到一个 window 中的时候就会调用这个方法
         * @param element   元素
         * @param timestamp 进来的时间
         * @param window    元素所属的窗口
         * @param ctx 上下文
         * @return TriggerResult
         *      1. TriggerResult.CONTINUE ：表示对 window 不做任何处理
         *      2. TriggerResult.FIRE ：表示触发 window 的计算
         *      3. TriggerResult.PURGE ：表示清除 window 中的所有数据
         *      4. TriggerResult.FIRE_AND_PURGE : 表示先触发 window 计算，然后删除
window 中的数据
         * @throws Exception
         */
        @Override
        public TriggerResult onElement(Tuple2<String, Integer> element,
                                       long timestamp,
                                       GlobalWindow window,
                                       TriggerContext ctx) throws Exception {
            // 拿到当前 key 对应的 count 状态值
            ReducingState<Long> count =
ctx.getPartitionedState(stateDescriptor);
            // count 累加 1
            count.add(1L);
            // 如果当前 key 的 count 值等于 maxCount
            if (count.get() == maxCount) {
                count.clear();
                // 触发 window 计算，删除数据
                return TriggerResult.FIRE;
            }
            // 否则，对 window 不做任何的处理
            return TriggerResult.CONTINUE;
        }

        @Override
        public TriggerResult onProcessingTime(long time,
                                              GlobalWindow window,
                                              TriggerContext ctx) throws
Exception {
            // 写基于 Processing Time 的定时器任务逻辑
            return TriggerResult.CONTINUE;
        }

        @Override
        public TriggerResult onEventTime(long time,
                                         GlobalWindow window,
                                         TriggerContext ctx) throws Exception
{
            // 写基于 Event Time 的定时器任务逻辑
            return TriggerResult.CONTINUE;
        }

        @Override
        public void clear(GlobalWindow window, TriggerContext ctx) throws
Exception {
            // 清除状态值
            ctx.getPartitionedState(stateDescriptor).clear();
        }
    }
    private static class MyCountEvictor
            implements Evictor<Tuple2<String, Integer>, GlobalWindow> {
        // window 的大小
        private long windowCount;

        public MyCountEvictor(long windowCount) {
            this.windowCount = windowCount;
        }

        /**
         *  在 window 计算之前删除特定的数据
         * @param elements  window 中所有的元素
         * @param size  window 中所有元素的大小
         * @param window    window
         * @param evictorContext    上下文
         */
        @Override
        public void evictBefore(Iterable<TimestampedValue<Tuple2<String,
Integer>>> elements,
                                int size, GlobalWindow window, EvictorContext
evictorContext) {
            if (size <= windowCount) {
                return;
            } else {
                int evictorCount = 0;
                Iterator<TimestampedValue<Tuple2<String, Integer>>> iterator =
elements.iterator();
                while (iterator.hasNext()) {
                    iterator.next();
                    evictorCount++;
                    // 如果删除的数量小于当前的 window 大小减去规定的 window 的大小,
就需要删除当前的元素
                    if (evictorCount > size - windowCount) {
                        break;
                    } else {
                        iterator.remove();
                    }
                }
            }
        }

        /**
         *  在 window 计算之后删除特定的数据
         * @param elements  window 中所有的元素
         * @param size  window 中所有元素的大小
         * @param window    window
         * @param evictorContext    上下文
         */
        @Override
        public void evictAfter(Iterable<TimestampedValue<Tuple2<String,
Integer>>> elements,
                               int size, GlobalWindow window, EvictorContext
evictorContext) {

        }
    }


    }
```

4.3.4 window增量聚合

窗口中每进入一条数据，就进行一次计算，等时间到了展示最后的结果

常用的聚合算子

```
reduce(reduceFunction)
aggregate(aggregateFunction)
sum(),min(),max()
```



```
/**
 * 演示增量聚合
 */
public class SocketDemoIncrAgg {
    public static void main(String[] args) throws  Exception{
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("localhost", 8888);
        SingleOutputStreamOperator<Integer> intDStream = dataStream.map(number
-> Integer.valueOf(number));
        AllWindowedStream<Integer, TimeWindow> windowResult =
intDStream.timeWindowAll(Time.seconds(10));
       windowResult.reduce(new ReduceFunction<Integer>() {
           @Override
           public Integer reduce(Integer last, Integer current) throws
Exception {
               System.out.println("执行逻辑"+last + "  "+current);
               return last+current;
           }
       }).print();


        env.execute(SocketDemoIncrAgg.class.getSimpleName());
    }
}
```

aggregate算子

需求：求每隔窗口里面的数据的平均值

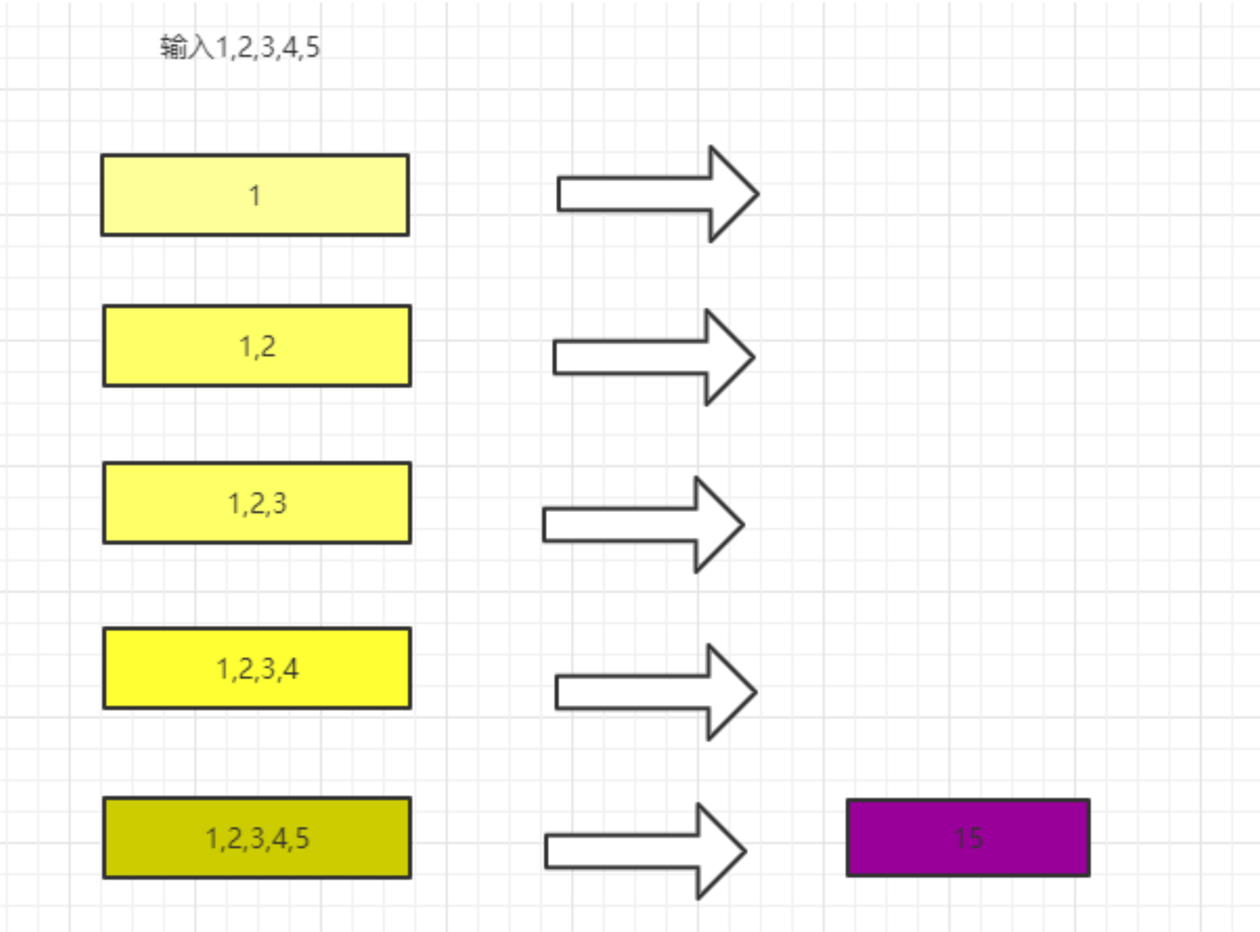
```
/**
 * 求每隔窗口中的数据的平均值
 */
public class aggregateWindowTest {
    public static void main(String[] args)  throws Exception{
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("10.148.15.10", 8888);

        SingleOutputStreamOperator<Integer> numberStream = dataStream.map(line
-> Integer.valueOf(line));
        AllWindowedStream<Integer, TimeWindow> windowStream =
numberStream.timeWindowAll(Time.seconds(5));
        windowStream.aggregate(new MyAggregate())
                .print();

        env.execute("aggregateWindowTest");
    }

    /**
     * IN，输入的数据类型
     * ACC,自定义的中间状态
     *      Tuple2<Integer,Integer>:
     *          key：计算数据的个数
     *          value:计算总值
     * OUT，输出的数据类型
     */
    private static class MyAggregate
            implements
AggregateFunction<Integer,Tuple2<Integer,Integer>,Double>{
        /**
         * 初始化 累加器
         * @return
         */
        @Override
        public Tuple2<Integer, Integer> createAccumulator() {
            return new Tuple2<>(0,0);
        }

        /**
         * 针对每个数据的操作
         * @return
         */
        @Override
        public Tuple2<Integer, Integer> add(Integer element,
                                            Tuple2<Integer, Integer>
accumulator) {
            //个数+1
            //总的值累计
            return new Tuple2<>(accumulator.f0+1,accumulator.f1+element);
        }

        @Override
        public Double getResult(Tuple2<Integer, Integer> accumulator) {
            return (double)accumulator.f1/accumulator.f0;
        }

        @Override
        public Tuple2<Integer, Integer> merge(Tuple2<Integer, Integer> a1,
                                              Tuple2<Integer, Integer> b1) {
            return Tuple2.of(a1.f0+b1.f0,a1.f1+b1.f1);
        }
    }
}
```

4.3.5 window全量聚合

等属于窗口的数据到齐，才开始进行聚合计算【可以实现对窗口内的数据进行排序等需求】

```
apply(windowFunction)
process(processWindowFunction)
processWindowFunction比windowFunction提供了更多的上下文信息。类似于map和RichMap的关系
```

效果图



```
/**
 * 全量计算
 */
public class SocketDemoFullAgg {
    public static void main(String[] args) throws  Exception {
        StreamExecutionEnvironment env =
StreamExecutionEnvironment.getExecutionEnvironment();
        DataStreamSource<String> dataStream =
env.socketTextStream("localhost", 8888);
        SingleOutputStreamOperator<Integer> intDStream = dataStream.map(number
-> Integer.valueOf(number));
```

```
        AllWindowedStream<Integer, TimeWindow> windowResult =
intDStream.timeWindowAll(Time.seconds(10));
        windowResult.process(new ProcessAllWindowFunction<Integer, Integer,
TimeWindow>() {
            @Override
            public void process(Context context, Iterable<Integer> iterable,
Collector<Integer> collector) throws Exception {
                System.out.println("执行计算逻辑");
                int count=0;
                Iterator<Integer> numberiterator = iterable.iterator();
                while (numberiterator.hasNext()){
                    Integer number = numberiterator.next();
                    count+=number;
                }
                collector.collect(count);
            }
        }).print();

        env.execute("socketDemoFullAgg");
    }
}
```

4.3.6 window join

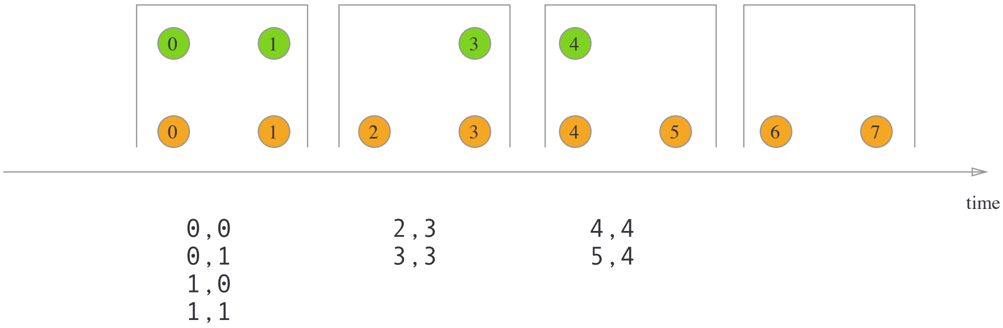
两个window之间可以进行join，join操作只支持三种类型的window：滚动窗口，滑动窗口，会话窗口

使用方式：

```
stream.join(otherStream) //两个流进行关联
    .where(<KeySelector>) //选择第一个流的key作为关联字段
    .equalTo(<KeySelector>)//选择第二个流的key作为关联字段
    .window(<WindowAssigner>)//设置窗口的类型
    .apply(<JoinFunction>) //对结果做操作  process  apply = foreachWindow
```

Tumbling Window Join

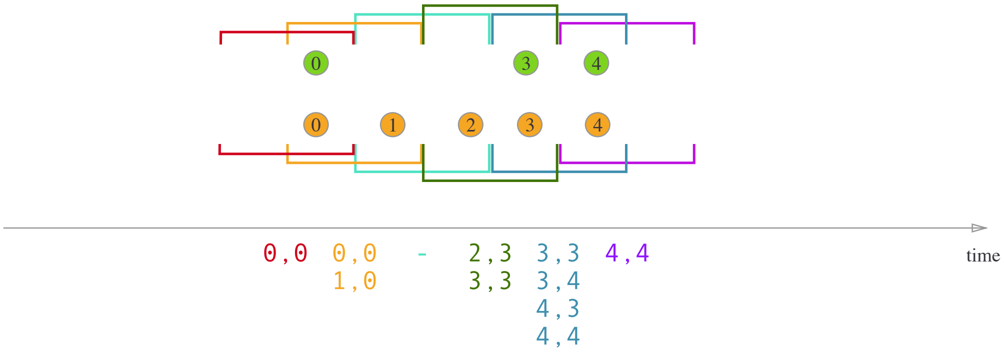
```
import org.apache.flink.api.java.functions.KeySelector;
import
org.apache.flink.streaming.api.windowing.assigners.TumblingEventTimeWindows;
import org.apache.flink.streaming.api.windowing.time.Time;

...

DataStream<Integer> orangeStream = ...
DataStream<Integer> greenStream = ...

orangeStream.join(greenStream)
    .where(<KeySelector>)
    .equalTo(<KeySelector>)
    .window(TumblingEventTimeWindows.of(Time.milliseconds(2)))
    .apply (new JoinFunction<Integer, Integer, String> (){
        @Override
        public String join(Integer first, Integer second) {
            return first + "," + second;
        }
    });
```



```
0,0            2,3            4,4
0,1            3,3            5,4
1,0
1,1
```

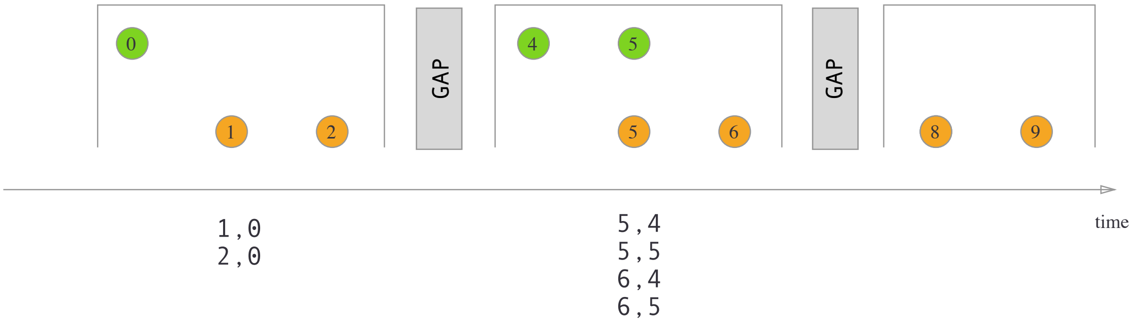
Sliding Window Join

```
import org.apache.flink.api.java.functions.KeySelector;
import
org.apache.flink.streaming.api.windowing.assigners.SlidingEventTimeWindows;
import org.apache.flink.streaming.api.windowing.time.Time;

...

DataStream<Integer> orangeStream = ...
DataStream<Integer> greenStream = ...

orangeStream.join(greenStream)
    .where(<KeySelector>)
    .equalTo(<KeySelector>)
    .window(SlidingEventTimeWindows.of(Time.milliseconds(2) /* size */,
Time.milliseconds(1) /* slide */))
    .apply (new JoinFunction<Integer, Integer, String> (){
        @Override
        public String join(Integer first, Integer second) {
            return first + "," + second;
        }
    });
```



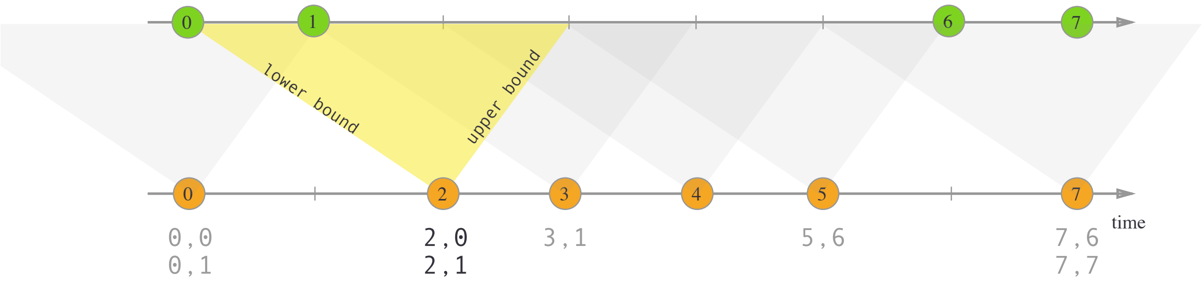
Session Window Join

```
import org.apache.flink.api.java.functions.KeySelector;
import
org.apache.flink.streaming.api.windowing.assigners.EventTimeSessionWindows;
import org.apache.flink.streaming.api.windowing.time.Time;

...

DataStream<Integer> orangeStream = ...
DataStream<Integer> greenStream = ...

orangeStream.join(greenStream)
    .where(<KeySelector>)
    .equalTo(<KeySelector>)
    .window(EventTimeSessionWindows.withGap(Time.milliseconds(1)))
    .apply (new JoinFunction<Integer, Integer, String> (){
        @Override
        public String join(Integer first, Integer second) {
            return first + "," + second;
        }
    });
```



Interval Join

```
import org.apache.flink.api.java.functions.KeySelector;
import org.apache.flink.streaming.api.functions.co.ProcessJoinFunction;
import org.apache.flink.streaming.api.windowing.time.Time;

...

DataStream<Integer> orangeStream = ...
DataStream<Integer> greenStream = ...

orangeStream
    .keyBy(<KeySelector>)
    .intervalJoin(greenStream.keyBy(<KeySelector>))
    .between(Time.milliseconds(-2), Time.milliseconds(1))
    .process (new ProcessJoinFunction<Integer, Integer, String(){

        @Override
        public void processElement(Integer left, Integer right, Context ctx,
Collector<String> out) {
            out.collect(first + "," + second);
        }
    });
```



六 、总结（5分钟）

1. 熟练掌握Window的类型
2. 掌握window的常用方法

七 、作业

后续有一个大作业

八 、互动